DISCUSSION AND CORRESPONDENCE

NOTES ON THE FOSSIL VERTEBRATES COLLECTED ON THE COPE EXPEDITION TO THE JUDITH RIVER AND COW ISLAND BEDS, MONTANA, IN 1876[1]

As I was Professor E. D. Cope's assistant on the above expedition, and as such diverse opinions are held regarding the stratigraphy of this Montana district, I have thought it of interest to try and disentangle the muddle, and to show that the Montana beds are to be correlated with those of Red Deer River, Alberta, on the evidence of their vertebrate fossils.

The following list gives the species collected by us in 1876, and described by Professor Cope, in camp on Dog Creek, four miles east of Judith River. I mention only the specimens I remembered positively, and collected (or handled), from the top of the "bad-lands" on Dog Creek. We were camped on the narrow flood plain, and every morning at daybreak we mounted our horses and climbed to the top of the strata, where our real work began. We passed over what Cope called the Pierre and Fox hills groups of Dr. Hayden, to the latter's typical locality, from which he secured the material described by Dr. Leidy, viz., of *Trachodon, Deinodon, Trionyx,* etc. We secured many specimens of these types, and many Cope described as new to science. Among them are the following: *Myledaphus bipartitus* Cope, *Hedronchus sternbergi* Cope, *Trionyx foveatus* Leidy, *Trionyx vagans* Cope, *Compsemys imbricarius* Cope, *Compsemys victus* Leidy, *Compsemys obscurus* Leidy, *Deinodon horridus* Leidy, *Deinodon (Aublysodon) lateralis* Cope, *Deinodon hayzenianus* Cope, *Deinodon (Lælaps) incrassatus* Cope, *Palæoscincus costatus* Leidy, *Dysganus encaustus* Cope, *Dysganus haydenianus* Cope, *Dysganus bicarinatus* Cope, *Dysganus peiganus* Cope, *Trachodon mirabilis* Leidy, *Diclonius pentagonus* Cope, *Diclonius perangulatus* Cope and *Diclonius calamarius* Cope.

We then followed the prairie forty miles down to Cow Island, and went into camp three miles below the landing on the opposite (south) side of the Missouri River. Here no teeth, fragments of bones nor turtle shells were found on the surface, as on Dog Creek.

It was possible to locate the bones in one way only, viz., by noticing the color of the surface dust above the bones, which in all cases differed from that of the surrounding disintegrated rock. By digging beyond the action of the frost we found the following species of Cope—*Monoclonius crassus, Monoclonius spenocerus, Monoclonius recurvicornis* and *fissus.* The *Monoclonius crassus* was found by Cope, at least the type; Mr. Isaac also got a *crassus.* Cope's specimen was found on the south side of the river in the hills about three miles below Cow Island. My specimens of which I got *recurvicornis* and *spenocerus* came from the north side of the river about four miles below Cow Island Landing, and Mr. Isaac's a mile farther down on the same side of the river, both near the flood plain.

I had the pleasure last year, and the year before, of exploring the Edmonton and Belly River series of Red Deer River, Alberta, and to me the succession of the rocks appears to be the same as in Montana, from the mouth of the Judith River to Cow Island.

At Dog Creek are the typical Judith River beds of Hayden and Cope, followed below by the Fox-Hill-Pierre, which are in turn underlain by the Cow Island beds, the Judith River beds correlating with the Edmonton, and the Cow Island with the Belly River series.

In descending Red Deer River last June from Drumheller to Berry Creek, a distance of eighty miles, the Pierre beds were seen appearing from beneath the Edmonton, and the Belly River from beneath the Pierre.

The evidence of the fossils corroborates the distinction between the Cow Island beds and the Judith River beds at Dog Creek. The trachodonts of the Belly River formation, for instance, are quite distinct from those of the Judith River and Edmonton. Take, for example, *Gryposaurus notabilis* Lambe, with its short heavy skull, high quadrate and elevated nasal. Again the resemblance of the Belly

[1] Published with the permission of the Director of the Canadian Geological Survey.

River *Ceratopsia* to those of the Cow Island beds is marked. Lambe's *Centrosaurus apertus* is much like Cope's *Monoclonius crassus*. The skull of the great spiked dinosaur *Styracosaurus albertensis* Lambe, the most unique of the horned dinosaurs, appears to be related to Cope's *Monoclonius sphenocerus*. The Edmonton *Trachodon* secured from Macheche Creek six miles above Drumheller, on the Red Deer River, Alberta, is closely related to *Trachodon annectens* from the Lance formation.

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"HYDRAULICS" IN THE ENCYCLOPEDIA BRITANNICA

TO THE EDITOR OF SCIENCE: While examining the article "Hydraulics" in the eleventh edition of the Encyclopædia Britannica, Vol. 14, p. 35, I discovered three errors, one of which, at least, is worthy of note in SCIENCE, as it may cause some one to lose valuable time if the published figures are taken too seriously.

The first and most serious of these errors is the value of the coefficient of viscosity for water at 77° F. which is stated to be 0.00000191 in lbs. per sq. ft. per unit velocity gradient in feet per second.[1]

The correct equation for this value in C.G.S. units is

$$\text{Coefficient of viscosity} = \frac{0.0178}{1 + .0337t + .000221t^2}$$

t being in centigrade degrees.[2]

If the numerator be multiplied by the number of square centimeters in one foot and divided by the number of dynes in one pound while the value of t is replaced by $(t - 32) \times 5 \div 9$, the expression for the coefficient of viscosity will become

$$\text{Coefficient of viscosity for water} = \frac{0.0000372}{.4700 + .0144t + .000068t^2}$$

the units being the foot, pound and Fahrenheit degree.

If 77 be now substituted for t the result will be the value of the coefficient for water at 77° F., or, 0.0000188, which is nearly ten times the value given by the Encyclopædia Britannica.

[1] See p. 35, upper right-hand part.

[2] See p. 536, Lamb's "Hydrodynamics," 1906.

Another error occurs in the same article, p. 77, near the top, equation (4). The last sign in the right-hand member should be a minus sign instead of a plus sign. The correct equation is

$$H_1 = \sqrt{(2u_0^2 H_0 \div g + \tfrac{1}{4}H_0^2)} - \tfrac{1}{2}H_0. \quad (4)$$

In Fig. 168, p. 90, the curve marked "Exper. III." should be marked "Exper. I." and the curve marked "Exper. I." should be marked "Exper. III.," the numerals evidently being transposed.

The error in the coefficient of viscosity was carried forward from the ninth edition of the Encyclopædia Britannica and was noted by me in 1909 in a paper on backwater published in *The Minnesota Engineer*, University of Minnesota.

B. F. GROAT

SCIENTIFIC BOOKS

Principles of Stratigraphy. By AMADEUS W. GRABAU, S.M., S.D., Professor of Paleontology in Columbia University. New York, A. G. Seiler and Co. 1913. Pp. xxxii + 1185 + index, with numerous illustrations.

This is a monumental work, one which presents fully and systematically the newer viewpoints in the interpretation of the rocks as the record of geologic history. For this reason it will be of great value, especially to the younger generation of American geologists, in broadening their mental horizon and outlining the problems which rise for solution in the twentieth century study of the rocks. It differs from other manuals in the English language to such a degree that it supplements but does not supplant them. It contains a notably large incorporation of material from German sources and makes full use of recent critical literature of both foreign and American authors. Nearly all of the older geologic manuals, although valuable encyclopedias of geologic science, have stored up the proven knowledge of the past, but have not pointed out the fields for investigation. They have further emphasized facts and principles as explaining facts, rather than as criteria of interpretation. This work contains a wealth of facts, though differing quite largely from that assemblage which has been carried down